Chief, Hawaii Bureau, FBIS   5 August 1948

Chief Engineer, FBIB

Medium Wave Multicoupler.

1. This will acknowledge receipt of your memorandum dated 28 July 1948, covering this subject.

2. At study of data furnished by you indicates that the following steps should be taken to produce more ideal conditions for the medium wave multicoupler.

a. The Beverage Wave antenna should be terminated to eliminate reception of strong local or near local signals from the back side. If reception on such strong stations were desired from the forward direction, a Beverage Wave antenna would not be used as it collects too much signal. The Beverage Wave antenna is useful for reception of long and medium wave signals from great distances, but should not be used on stations less than 3 to 5 hundred miles away.

b. Check carefully all grounds at the station to determine if their resistance is low and if their contacts are very good. Rectification at these contacts, due to presence of very strong RF signals, produces what is known as "External Cross-Modulation"--which is what your results indicate is happening.

c. Check the tubes in the multicoupler to determine if any of them show abnormally high spurious response level.

3. Some data will now be furnished to guide you in this work.

a. It is recollected that the Kauai Beverage Wave antenna is not terminated on the far end to absorb the strong signals received from the rear--from Oahu. Insertion of a 5-watt, 500 ohm, potentiometer between the two antenna wires (tied together) and the ground will accomplish the desired effect if the down lead and potentiometer are shielded (a piece of RG-12/U will do) to prevent omni-directional pick-up of strong local signals. The potentiometer should be mounted in a can in such fashion that it may be adjusted to the surge impedance of the Beverage Wave antenna--about 350 ohms. The transformer on the near end pole should be removed and an Andrews coupling transformer substituted for it. The connection from the transformer into the building should be via RG-12/U cable, brought in overhead. Ground the shield of the cable and the transformer case well to the ground wire on the pole. Check to see that the ground connection is well made to the ground rod near the base of this pole.

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b. Run a separate low resistance ground directly from the multicoupler to a ground rod driven into moist ground under the eaves of the building. Make sure the connections are positive. Saturate the ground around all station grounds with salt water. Check ground connections on all grounds and on all radio and electrical equipment at the station. If any contacts are loose or dirty, clean them with sandpaper and CTC. Where possible, solder ground connections.

The term "external cross-modulation" is applied to spurious frequencies generated by nonlinear or rectifying contacts in conduct, switch blades, ground connections, light wires, etc., that carry currents induced by the signal, near the receiver or multicoupler. When strong radio signals are present, such nonlinear contacts develop new frequencies in appreciable amplitude. These signals reach the receiver or multicoupler by conduction or by direct radiation, causing signals to be heard at unexpected places on the dial. The most common new frequencies produced are harmonics of the transmitted carrier and simple combination frequencies of two or more carriers of the type $a \pm b$, $a \pm 2b$, $2a \pm b$, $a + b \pm c$, $a \pm c$, $a \pm b + c$, etc. In the case where the rectifying contact is on a power line, there is the possibility of strong hum modulation being produced on the carrier frequency of the station being received.

The attached tables will indicate the relationships between the signals reported as received by you when using the multicoupler.

c. Some new tubes are often found unfit for use in multicouplers because they produce an abnormally high spurious response level. These tubes are perfectly good for other applications as they have a satisfactory plate current drain, transconductance, and internal resistance. The best method of detecting such faulty tubes is to feed two strong signals (from signal standards or generators) into the input of the multicoupler unit and measure the strength of one of the intermodulation products. By comparing several tubes a poor one may be detected. The strong signals used for this purpose should be in the order of 10,000 to 20,000 microvolts.

4. Further details can be furnished if desired. Results of your further tests are awaited with great interest.

For the Chief, FBIB:

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Enclosure A

KGMB	590KC	Fundamental		5KW
"	1180KC	2nd harmonic		
"	1221.5KC	Should be 1220KC. Sum frequency of KGMB, 590KC and KPOA, 630KC.		
"	1280.8KC	Should be 1280KC. Sum frequency of KGMB, 590KC and KULA, 690KC.		
"	1351.8KC	Should be 1350KC. Sum of KGMB, 590KC and KGU, 760KC.		
KPOA	630KC	Fundamental		5KW
"	1221.1KC	Should be 1220KC. Sum frequency of KPOA, 630KC and KGMB, 590KC.		
"	1260KC	Second Harmonic		
"	1321KC	Should be 1320KC. Sum frequency of KPOA, 630KC and KULA, 690KC.		
KHON	1380KC	Fundamental	(0.250KW on 1400) (5KW on 1380 (CP)) (CP) - Construction Permit	
KULA	690KC	Fundamental		10KW
"	1280.8KC	Should be 1280KC. Sum frequency of KULA, 690KC and KGMB, 590KC.		
"	1321KC	Should be 1320KC. Sum frequency of KULA, 690KC and KPOA, 630KC.		
"	1380KC	Second Harmonic.		
"	2450.9KC	Should be 1450KC. Sum frequency of KULA, 690KC and KGU, 760KC.		
KGU	760KC	Fundamental		2.5KW
KGU	1352.8KC	Should be 1350KC. Sum frequency of KGU, 760KC and KGMB, 590KC.		
"	1520KC	Second Harmonic		

Listening on higher frequencies may produce more similar signals with reduced signal level.

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